iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** I **Month of publication:** January 2026

DOI: https://doi.org/10.22214/ijraset.2026.76755

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue I Jan 2026- Available at www.ijraset.com

Mapping Convergence Between Modern Chronobiology and Traditional Organ-Time Systems

Dr. Jayant Nagar[1], Dr. Vanita Nagar[2], Dr. Satyendra Singh[3], Dr. Rakhee Sharma[4], Dr. Spriha Singh[5]
[1]*BAMS, MD, Assistant Professor, Department of Swasthavritta& Yoga, Chaudhary Devi Lal College of Ayurveda & Hospital, Yamunanagar, Haryana*
[`2]*BAMS, MD, Kayachikitsa, Ayurvedic Medical Officer, Govt. Ayurveda Dispensary Geeta Bhawan, Yamunanagar, Haryana*
[3]*BNYS,MD, Senior Research Fellow,Central Council for Yoga & Naturopathy(CCRYN), Ministry of Ayush*
[4]*BNYS, MD, Subharti University, Meerut*
[5]*BAMS Scholar, Sanskriti Ayurvedic Medical College & Hospital, Mathura*

Abstract: ***Circadian rhythms are endogenous, self-sustained biological oscillations with a periodicity of approximately twenty-four hours that govern a wide range of physiological and behavioral processes, including sleep–wake cycles, metabolism, endocrine secretion, immune regulation, and cognitive performance. Long before the molecular architecture of the circadian clock was identified, traditional medical systems such as Ayurveda, Yoga, Naturopathy, and Traditional Chinese Medicine (TCM) proposed time-dependent frameworks for understanding organ function, digestion, mental states, and disease susceptibility. The emergence of modern chronobiology has provided mechanistic insights into these ancient observations through the discovery of the suprachiasmatic nucleus (SCN), peripheral clocks, and clock genes such as CLOCK, BMAL1, PER, and CRY.***

This review integrates contemporary circadian science with traditional organ-time concepts, evaluates mechanistic plausibility, and explores the role of lifestyle-based chrono-regulatory interventions including yoga, breathwork, fasting, and light exposure. Furthermore, it outlines future research directions using chronobiometric tools such as dim light melatonin onset (DLMO), heart rate variability (HRV), continuous glucose monitoring, and wearable-derived temperature rhythms to empirically investigate traditional timing systems. The synthesis presented here suggests that integrative chronomedicine holds significant promise for preventive healthcare, chronotherapy, and personalized lifestyle interventions.

Keywords: Circadian, Chronobiology, Zeitgeber, Chronotherapy

I. INTRODUCTION

The scientific understanding of biological rhythms has evolved through several landmark discoveries that collectively established time as a fundamental dimension of physiology. In 1729, the French astronomer Jean-Jacques d'Ortous de Mairan demonstrated that the leaves of *Mimosa pudica* continued to exhibit rhythmic opening and closing even in constant darkness, thereby providing the first experimental evidence that biological rhythms are endogenously generated rather than purely driven by environmental cues. More than two centuries later, in 1959, Franz Halberg introduced the term "circadian" to describe rhythms that oscillate with an approximately twenty-four-hour periodicity. The field of chronobiology reached a molecular turning point in 2017, when Jeffrey C. Hall, Michael Rosbash, and Michael W. Young were awarded the Nobel Prize in Physiology or Medicine for elucidating the genetic and molecular mechanisms underlying circadian regulation.

These discoveries confirmed a principle that had been implicitly recognized by traditional healing systems for millennia: that biological function is not static but dynamically organized in time. Systems such as Ayurveda and TCM developed detailed temporal frameworks linking organ function, digestion, sleep, and mental states to daily and seasonal cycles. The convergence of these ancient insights with modern circadian science provides a unique opportunity to develop an integrative understanding of health and disease.(1)

©IJRASET: All Rights are Reserved

II. CONCEPTUAL FOUNDATIONS OF CIRCADIAN RHYTHMS

Circadian rhythms are intrinsic biological oscillations that persist even in the absence of external time cues, yet remain highly responsive to environmental signals. These rhythms regulate nearly every aspect of human physiology, including sleep–wake patterns, hormonal secretion, cardiovascular function, metabolic pathways, immune responses, and cognitive performance(2). The adaptive value of circadian rhythms lies in their ability to anticipate predictable environmental changes associated with the day–night cycle, thereby optimizing physiological efficiency and survival.

In humans, circadian rhythms interact with other temporal patterns, including ultradian rhythms, which have cycles shorter than twenty-four hours such as heart rate and respiratory rhythms, and infradian rhythms, which extend beyond twenty-four hours, such as the menstrual cycle. Among these, circadian rhythms play a central organizing role by coordinating internal physiological processes with the external environment.

III. ZEITGEBERS AND CIRCADIAN ENTRAINMENT

Although circadian rhythms are generated endogenously, their synchronization with the external world depends on environmental time cues known as zeitgebers. The light–dark cycle is the most powerful zeitgeber, providing daily information about solar time. Other zeitgebers include meal timing, physical activity, ambient temperature, and social interactions (3).

Light entrains the circadian system through intrinsically photosensitive retinal ganglion cells, which transmit photic signals directly to the SCN. Morning light exposure advances the circadian phase, whereas evening and nighttime light delays it, thereby influencing sleep timing and hormonal rhythms (4). These entrainment mechanisms are essential for correcting circadian misalignment associated with jet lag, shift work, and irregular lifestyles. Persistent disruption of circadian entrainment has been linked to adverse health outcomes, including metabolic disorders, cardiovascular disease, mood disturbances, and immune dysfunction (5).

IV. MECHANISMS OF CIRCADIAN REGULATION

At the apex of the mammalian circadian system lies the suprachiasmatic nucleus, a paired structure in the anterior hypothalamus that functions as the master pacemaker. The SCN integrates photic input from the retina and synchronizes peripheral clocks distributed throughout the body (3). Peripheral clocks are present in the liver, pancreas, heart, gastrointestinal tract, and immune cells, where they regulate tissue-specific metabolic and physiological processes (5).

At the molecular level, circadian rhythmicity is generated by transcriptional–translational feedback loops involving core clock genes. CLOCK and BMAL1 proteins activate the transcription of PER and CRY genes, whose protein products subsequently inhibit CLOCK–BMAL1 activity, completing a roughly twenty-four-hour cycle (6). This molecular oscillation underlies daily variations in insulin sensitivity, blood pressure, melatonin secretion, and the cortisol awakening response.

V. CIRCADIAN RHYTHMS AND HUMAN HEALTH

Circadian rhythms exert a profound influence on human physiology and disease susceptibility. Disruption of circadian alignment contributes to metabolic syndrome, type 2 diabetes, obesity, cardiovascular disease, sleep disorders, immune dysfunction, and chronic inflammation (2). Experimental and clinical studies demonstrate that insulin sensitivity peaks in the morning, hepatic detoxification enzymes exhibit nocturnal maxima, cardiovascular events occur more frequently in the early morning hours, and parasympathetic nervous system activity predominates during nighttimesleep(7).These findings underscore the critical role of timing in health maintenance and disease prevention.

VI. ORGAN-TIME SYSTEMS IN TRADITIONAL MEDICINE

Traditional medical systems conceptualized time-dependent physiology long before the advent of chronobiology. Ayurveda organizes daily rhythms according to the cyclical dominance of the three doshas—Vata, Pitta, and Kapha—which govern movement, transformation, and structure, respectively. These doshic cycles vary predictably across the day and night, influencing digestion, metabolism, mental clarity, and sleep (1). Classical Ayurvedic texts describe *Kala* (time) as a fundamental determinant of physiological change and emphasize the principle of *Loka–Purusha SamyaSiddhanta*, which posits a correspondence between human biology and cosmic rhythms.

Traditional Chinese Medicine similarly describes a horary organ clock, assigning two-hour periods of peak activity to each organ system. Notably, the liver's peak period between 1 and 3 a.m. corresponds with modern evidence of nocturnal hepatic metabolic and detoxification activity(4).

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

Although expressed symbolically, these systems reflect empirical observations that parallel modern chronobiological findings (1).

VII. YOGA, NATUROPATHY, AND CIRCADIAN ALIGNMENT

Yoga and naturopathy offer lifestyle-based interventions that implicitly regulate circadian rhythms through alignment with natural cycles. Hatha Yoga, traditionally interpreted as the union of solar (Ha) and lunar (Tha) energies, aims to balance opposing physiological forces and synchronize endogenous rhythms with cosmic cycles. Yogic models such as the PanchaKosha describe multiple layers of human existence, all influenced by rhythmic processes, ranging from the physical body to subtler mental and energetic dimensions.

Classical yogic texts, including the *Shiva Swarodaya*, emphasize the relationship between breath dominance, autonomic balance, and physiological rhythms. Practices such as regulated pranayama enhance vagal activity and improve heart rate variability, thereby supporting circadian stability(8,9). Advanced practices such as Khechari Mudra are traditionally believed to influence higher neuroendocrine centers, potentially affecting sleep–wake regulation, hunger, thirst, and meditative states.

Naturopathy emphasizes early eating, fasting, exposure to natural elements, and gut health as foundational principles. Contemporary research demonstrates that time-restricted feeding improves glucose regulation, blood pressure, sleep quality, and cognitive function through circadian mechanisms (7,10). The gut microbiota, which exhibits its own diurnal rhythmicity, plays a critical role in mediating these effects (11).

VIII. CHRONOTHERAPY AND INTEGRATIVE INTERVENTIONS

Chronotherapy represents a direct clinical application of circadian science. Aligning medication timing with biological rhythms improves efficacy and reduces adverse effects, as demonstrated for statins and antihypertensive agents(12,13). Nutritional timing, exercise scheduling, light exposure, and mind–body practices similarly influence circadian alignment. Many of these evidence-based strategies parallel recommendations found in traditional systems, such as consuming the largest meal at midday or sleeping during the early evening Kapha phase.

Comparative analysis reveals shared rhythmic principles:

Circadian Finding	Supporting Evidence	Ayurvedic Correlate	TCM Correlate
Morning metabolic peak	Longo & Panda, 2016 (*Cell Metabolism*)	Pitta period	Stomach/Spleen 7–11 am
Evening parasympathetic rise	Archer & Oster, 2015 (*Science*)	Kapha evening	Kidney/Pericardium
Nighttime liver activity	Reiter et al., 2010 (*Endocrine Reviews*)	Pitta night	Liver 1–3 am
Early-morning cortisol rise	Czeisler& Buxton, 2017 (*Sleep Medicine*)	Vata dawn	Lung 3–5 am

These parallels suggest shared empirical observations interpreted through different conceptual frameworks.

IX. CHRONOBIOMETRIC TOOLS FOR INTEGRATIVE MEDICINE RESEARCH

Recent advances in chronobiometric technologies enable objective assessment of circadian phase and rhythm integrity. Dim light melatonin onset is considered the gold standard marker of circadian phase, while cortisol awakening response reflects hypothalamic–pituitary–adrenal rhythmicity (14). Heart rate variability provides insight into autonomic oscillations, and wearable devices allow continuous monitoring of temperature, sleep, and activity rhythms (9,15). Continuous glucose monitoring reveals diurnal variation in metabolic responses and offers a powerful tool for validating traditional timing concepts (7).

X. DISCUSSION

The convergence of modern chronobiology with traditional medical systems reveals a shared recognition of temporal organization as a foundational principle of physiology. While traditional frameworks emerged from empirical observation and philosophical reasoning, contemporary science provides mechanistic explanations grounded in neurobiology, endocrinology, and molecular genetics (6).

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |

Integrative chronomedicine has the potential to enhance disease prevention, personalize treatment strategies, and inform lifestyle interventions. Future research should prioritize mechanistic studies examining the effects of yoga, fasting, and circadian-aligned living on clock gene expression and physiological rhythms.

XI. CONCLUSION

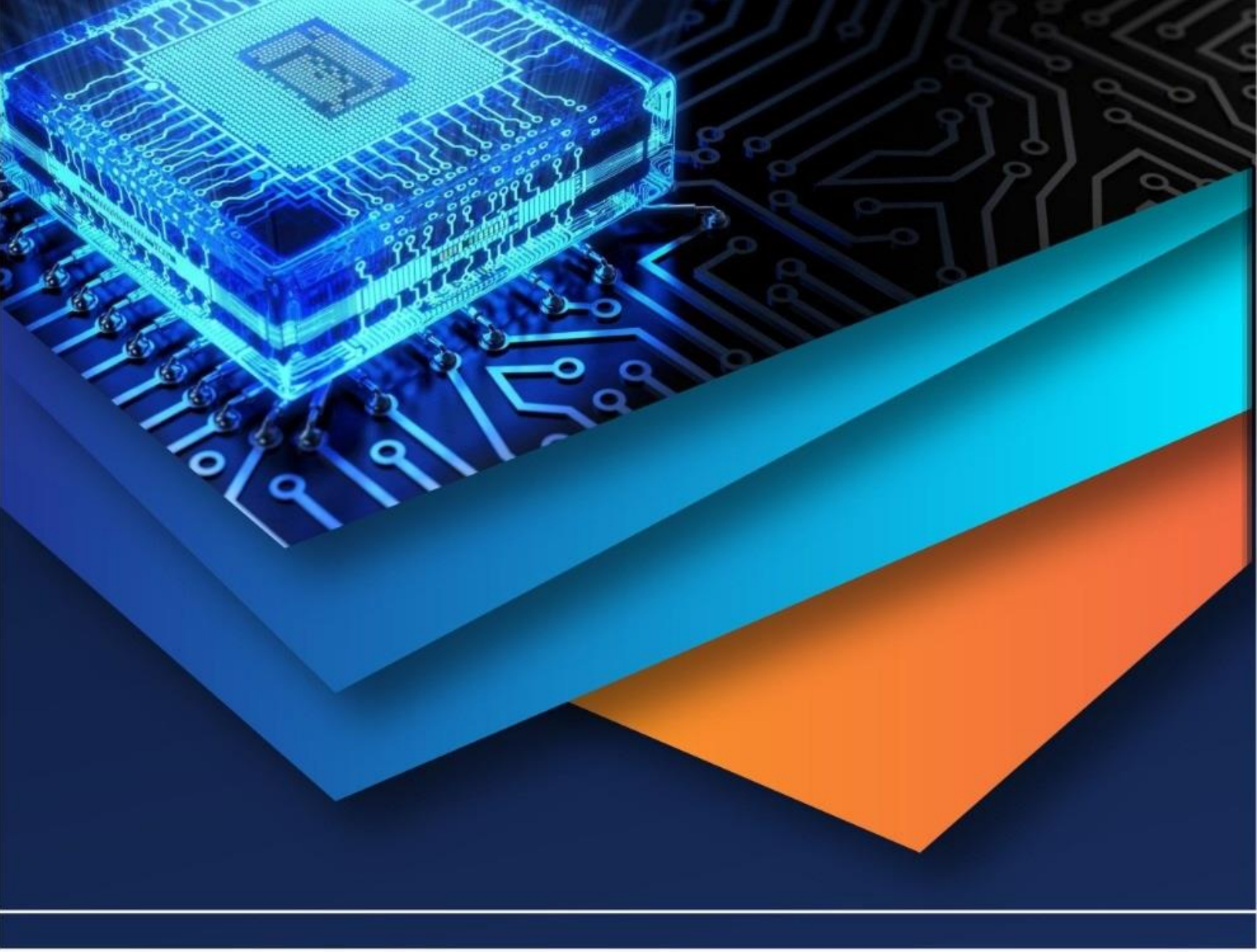
Traditional systems such as Ayurveda, Yoga, and Traditional Chinese Medicine articulated time-based models of health that closely parallel contemporary discoveries in circadian biology. Integrating these ancient frameworks with modern chronobiological science offers a robust and evidence-informed approach to optimizing metabolic health, mental wellbeing, and therapeutic efficacy. The development of integrative chronomedicine, supported by chronobiometric validation, represents a promising frontier in preventive and personalized healthcare.

Conflict of Interest: Nil

REFERENCES

[1] Foster RG, Kreitzman L. The rhythms of life: Chronobiology and health. Nature Reviews. 2014;
[2] Czeisler CA, Buxton OM. Human circadian timing system and sleep-wake regulation. In: Principles and Practice of Sleep Medicine. Elsevier; 2017. p. 362-376.e5.
[3] Hastings MH, Maywood ES, Brancaccio M. Generation of circadian rhythms in the SCN. Nature Reviews Neuroscience. 2019;20:453–69.
[4] Mirza-Aghazadeh-Attari M, Reiter RJ, Rikhtegar R, Jalili J, Hajalioghli P, Mihanfar A, et al. Melatonin: An atypical hormone with major functions in the regulation of angiogenesis. IUBMB Life [Internet]. 2020;72(8):1560–84. Available from: http://dx.doi.org/10.1002/iub.2287
[5] Cedernaes J. Effects of circadian disruption on metabolism. Cell Metabolism. 2019;29(3):517–28.
[6] Partch CL, Green CB, Takahashi JS. Molecular architecture of the mammalian circadian clock. Trends Cell Biol [Internet]. 2014;24(2):90–9. Available from: http://dx.doi.org/10.1016/j.tcb.2013.07.002
[7] Longo VD, Panda S. Fasting, circadian rhythms, and time-restricted feeding in healthy lifespan. Cell Metab [Internet]. 2016;23(6):1048–59. Available from: http://dx.doi.org/10.1016/j.cmet.2016.06.001
[8] Vollbehr NK, Bartels-Velthuis AA, Nauta MH, Castelein S, Steenhuis LA, Hoenders HJR, et al. Hatha yoga for acute, chronic and/or treatment-resistant mood and anxiety disorders: A systematic review and meta-analysis. PLoS One [Internet]. 2018;13(10):e0204925. Available from: http://dx.doi.org/10.1371/journal.pone.0204925
[9] Archer SN, Oster H. How sleep and wakefulness influence circadian rhythmicity: effects of insufficient and mistimed sleep on the animal and human transcriptome. J Sleep Res [Internet]. 2015;24(5):476–93. Available from: http://dx.doi.org/10.1111/jsr.12307
[10] Cuevas-Cervera M, Perez-Montilla JJ, Gonzalez-Muñoz A, Garcia-Rios MC, Navarro-Ledesma S. The effectiveness of intermittent fasting, time restricted feeding, caloric restriction, a ketogenic diet and the Mediterranean diet as part of the treatment plan to improve health and chronic musculoskeletal pain: A systematic review. Int J Environ Res Public Health [Internet]. 2022;19(11):6698. Available from: http://dx.doi.org/10.3390/ijerph19116698
[11] Thaiss CA, Levy M, Korem T, Dohnalová L, Shapiro H, Jaitin DA, et al. Microbiota diurnal rhythmicity programs host transcriptome oscillations. Cell [Internet]. 2016;167(6):1495-1510.e12. Available from: http://dx.doi.org/10.1016/j.cell.2016.11.003
[12] Reinberg A, Smolensky M. Chronotherapy of medications. Chronobiology International. 2019;
[13] Smolensky MH, Hermida RC. Chronobiology and chronotherapy of cardiovascular disease. Sleep Medicine Reviews. 2015;
[14] Zee PC, Attarian H. Clinical management of circadian rhythm disorders. New England Journal of Medicine. 2018;
[15] Thomas C. Wearables in circadian health research. Sleep and Biological Rhythms. 2020;

©IJRASET: All Rights are Reserved | SJ Impact Factor 7.538 | ISRA Journal Impact Factor 7.894 |



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)